CATHODIC TEST LEAD AND PIG MONITORING SYSTEM

FIELD OF THE INVENTION

The present invention relates to computer controlled pipeline monitoring and, more specifically, to multiple monitoring stations which may each include cathodic test leads for detecting pipe/soil potentials, a pipeline pig detector, a pipe damage detector, and a satellite communications module for communication with a central monitoring facility.

BACKGROUND OF THE INVENTION

Pipelines are utilized throughout the world to transport a variety of liquid products, including oil, petroleum products, natural gas, and chemicals. Over a period of time, contaminates or residues accumulate on the inner walls of the pipe, thereby reducing pipeline flow efficiency. In order to extract the build up, an internal traveler known as a pig is propelled through the pipe. Besides cleaning the interior walls of the pipe, pigs are useful for pipe gauging, line fill and de-watering, product separation, leak detection, and corrosion, internal thermal, and/or video surveys.

Because pigs are susceptible to becoming obstructed within the pipe, knowing the location of the pig is critical. In order to ensure accurate location, it is necessary to monitor the pig's progress during pumping (pig propelling) operations. Noise making devices, such as chains or wall tapping devices, have been used to track the location of pigs. However, this method is expensive since crews of technicians stationed at points along the route of the pipeline are required to listen for the pig. Low frequency electromagnetic transmitters have been attached to the pig, but these require on-board power, which is susceptible to failure or power loss. In some countries, hazardous radioactive tracers are used. Offshore operators use pingers, which provide periodic sonic pulses. The seawater acts as a conductor of the sonic pulse for a surface receiver. Using the above techniques, receiving a locating signal from the pig was often unreliable.

Pig monitoring stations were developed to indicate the passage of the pig along a point, or station, of the pipeline. A mechanical signaling device was inserted into a small hole of the pipeline, allowing a lever to hang down into the pipe. Upon the passage of the pig, the lever was hit which set a visual flag on the external surface of the pipe. Later, micro-switches were added which sent a closure signal to a console to indicate passage of the pig. Although these mechanisms provide location data, the intrusion created for the mechanical signaling device undesirably affect the integrity of the pipeline since the entire system must be shut down for maintenance of the pig passage signaling device.

Non-intrusive pig detector mechanisms were developed which used magnetic passage indicators and a permanent magnetic circuit that became part of the pig's construction, becoming a "magnetic pig". The magnetic circuit could be attached to most types of pigs, including inflatable spheres. The magnetic pig created a magnetic field sufficient to saturate the wall of the pipe through which the pig is traveling. Magnetic passage indicators, placed along the length of the pipeline and in close proximity to the pipe wall, allowed the operator to track the pig through the pipeline. Each magnetic passage indicator signaled the pig's arrival and indicated the time of the event. A subsea passage indicator included the ability to transmit the signal either acoustically or via an underwater umbilical to the surface. Permanently mounted passage indicators were adapted to radio telemetry.

Sensitive magnetic sensing instruments, such as flux-gate gradiometers, have been utilized successfully to locate the pig, provided the pipeline is not buried too deep. In marine applications, a diver equipped with a marine flux-gate gradiometer is commonly used to locate the pig. These techniques have significant disadvantages in that they use significant personnel to perform the search and hopefully locate the pig.

All forms of pigs are susceptible to becoming lost or obstructed during their travel from one section of the pipeline to another. Once found, the pig can be extracted or corrected. Since magnetic passage indicators provide indications to locate the pig between two known points with time-of-event data, the pig can be accurately tracked. However, the distance between magnetic passage indicators may be as great as several miles, and the expense of locating the lost pig includes high personnel costs and long delays, leading to lost production. A more efficient and timely determination of the pig's position is desired to reduce personnel costs and down time.

Inspection pigs are used to detect the extent of corrosion in oil and gas pipeline systems. The most common type of inspection pig is the magnetic flux leakage pig (MFL) which utilizes a strong magnetic field to saturate the wall of the pipe as the pig travels along the pipeline. Magnetic sensors positioned around the body of the pig detect deviations in the magnetic field, thus indicating pitting or corrosion of the wall of the pipeline. After detection of corrosion, it has been a problem to accurately identify, within a few feet, the location of the pig along the pipeline when the corrosion signal was obtained. An odometer has been used to count the footage traveled from the start of the operation. However, odometers may "skid", causing erroneous information. A higher degree of accuracy has been obtained utilizing an internal timer synchronized to the Global Positioning System (GPS) time prior to the launch of the pig. As the pig passes magnetic markers at monitoring stations which have been surveyed into GPS coordinates, the marker captures the event time. After the completion of the pig's survey run, the timing of the passage indicators is compared with the internal clock and the events detected by the inspection pig, thereby providing a more accurate indication of the location of pitting or corrosion along the pipeline.

In addition to concerns regarding pitting or corrosion of the internal pipe wall, corrosion also may occur on the outer wall or skin of the pipeline. Pipelines are protected from external corrosion by insulating the outer skin of the pipe from the earth using a coating or protective wrapping. Due to insufficient wrapping protection, the integrity of the cathodic protection at sections along the pipeline route may be susceptible to corrosion. In addition, a low voltage, typically −1.2 vdc, is applied to the pipe relative to ground. Current producing systems, known as cathodic protection rectifiers (CPRs), are positioned at strategic points along the pipeline route. CPRs produce a low voltage and a high amperage which is continuously applied to the pipeline. Cathodic test leads connected to the skin of the pipeline and to ground at these stations detect pipe/soil potentials with a voltmeter. A negative voltage between −1.2 vdc and −0.85 vdc is generally considered acceptable. Cathodic test lead stations may also provide a direct connection to the pipeline and a protective casing surrounding the pipeline. Protective casings are used at road crossings and are insulated from the wall of the pipeline. By utilization of a half cell electrode